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National Aeronautics and Space Administration Headquarters
Office of Biological and Physical Research
Washington, DC 20546

**RESEARCH OPPORTUNITIES IN
SPACE BIOLOGICAL AND PHYSICAL SCIENCES**

**BIOLOGICAL AND FLUID PHYSICS RESEARCH
FOR
HUMAN SUPPORT TECHNOLOGY**

**NEW
NASA RESEARCH ANNOUNCEMENT
NNH04ZUU004N**

Catalog of Federal Domestic Assistance (CFDA) Number: 00.000

**NRA ISSUED:
NOTICES OF INTENT DUE:
PROPOSALS DUE:**

**JUNE 29, 2004
JULY 29, 2004
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Executive Summary

This NASA Research Announcement (NRA), titled Research Opportunities in Space Biological and Physical Sciences, Human Support Technology, solicits basic research and research that enables technology development in support of the science missions of the Office of Biological and Physical Research (OBPR) of the National Aeronautics and Space Administration (NASA). This NRA is limited to specific aspects of biological research and fluid physics as they pertain to life support systems for future space exploration. These aspects include plant biology, microbial ecology, multiphase flow, and interfacial phenomena. Details of the solicited areas of research and development are given in Appendix A of this NRA. Solicited proposal types include ground-based research and ground-based Pilot Studies.

It is anticipated that a typical award for ground-based biological research will average approximately \$175-200K per year in total costs, and that a typical award for ground-based fluid physics research will average approximately \$110-120K per year in total costs. Support for Pilot Studies in biological research will be approximately \$100K per study for Phase I funding. Proposals for awards substantially greater than these amounts must provide adequate justification. Proposals will be funded in one-year increments for activities lasting up to three years for ground-based research. The funding duration will depend on proposal requirements, review panel recommendations, and continuing progress of the activity. Selected Pilot Studies will receive Phase I funding for a period of 12 months. Participation in this NRA is open to all categories of organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other Government agencies. Cost sharing is encouraged but not required. Awards will be made as grants or cooperative agreements, depending on the nature of the proposing organization and program requirements.

Education and Public Outreach are important objectives of NASA and OBPR. All investigators responding to this NRA whose projects are selected for funding are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the space environment, and OBPR programs through formal and informal education opportunities. Where appropriate, supported investigators will collaborate with NASA to develop a plan for communicating their work to the public.

Potential investigators should read with care the program descriptions that are of interest and focus their proposals on the specific research emphases defined in this Announcement. Specific Technical Points of Contact for each solicited area of research are provided in Appendix A of this NRA. In addition to this Announcement, proposal forms and other proposal materials are available at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.

Your interest and cooperation in participating in this effort is appreciated.

Original signed by

Mary E. Kicza
Associate Administrator
Office of Biological and Physical Research

**RESEARCH OPPORTUNITIES IN SPACE BIOLOGICAL AND PHYSICAL
SCIENCES, HUMAN SUPPORT TECHNOLOGY**

TABLE OF CONTENTS

SUMMARY OF SOLICITATION	3
I. Funding Opportunity Description	3
A. Introduction and Background	3
B. Support of Education and Outreach.....	4
C. NASA Safety Policy	5
D. Availability of Funds for Awards	5
II. Award Information.....	6
III. Eligibility Of Applicants.....	7
A. Eligible Applicants	7
B. Cost Sharing or Matching.....	7
C. Guidelines for International Participation.....	7
IV. Proposal and Submission Information	8
A. Source of Application Materials.....	8
B. Content and Form of Proposal Submission	8
C. Submission Dates and Times.....	20
D. Funding Restrictions.....	21
V. Proposal Review Information	22
A. Merit Review Evaluation Criteria.....	22
B. Review and Selection Process	23
VI. Award Administration Information	25
A. Award Notices	25
B. Administrative and National Policy Requirements	25
C. Award Reporting Requirements	26
VII. NASA Contacts And Concluding Statements.....	27
VIII. References.....	27
A. General References	27
B. Programmatic References	28
C. Other References.....	29
APPENDIX A: SCIENTIFIC/TECHNICAL DESCRIPTION	A-1
I. Introduction.....	A-1

II. Types of Proposals Sought.....	A-2
A. Pilot Studies (open only for Biological Research for Human Support Technology) .	A-3
B. Ground-Based Research (open to both Research Areas).....	A-4
III. Areas Of Research Emphasis.....	A-4
A. Biological Research for Human Support Technology.....	A-4
B. Fluid Physics Research for Human Support Technology.....	A-7
IV. Hardware And Facility Descriptions	A-12
APPENDIX B: SAMPLE FORMS.....	B-1

RESEARCH OPPORTUNITIES IN SPACE BIOLOGICAL AND PHYSICAL SCIENCES, HUMAN SUPPORT TECHNOLOGY

SUMMARY OF SOLICITATION

I. FUNDING OPPORTUNITY DESCRIPTION

A. Introduction and Background

The National Aeronautics and Space Administration (NASA) Vision is:

*To improve life here,
To extend life to there,
To find life beyond.*

On January 14, the President of the United States announced a new vision for NASA to:

- Implement a sustained and affordable human and robotic program to explore the solar system and beyond;
- Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;
- Develop the innovative technology, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and
- Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

The vision affirms the nation's commitment to space exploration and provides a clear direction for the civil space program. The activities carried out to implement this vision will be paced by experience, technology readiness, and affordability. Implementation involves key missions, including Moon and Mars exploration.

The Office of Biological and Physical Research (OBPR) contributes to this Vision through its support of research that addresses the following questions:

- How can we assure the survival of humans traveling far from Earth?
- How does life respond to gravity and space environments?
- What new opportunities can research bring to expand understanding of the laws of nature and to enrich lives on Earth?
- What technology must we create to enable the next explorers to go beyond where we have been?
- How can we educate and inspire the next generations to take the journey?

OBPR has developed a Strategy that provides a description of the direction that the Enterprise will take to answer these questions and fulfill its mission. The OBPR Strategy can be accessed at: http://spaceresearch.nasa.gov/general_info/strat.html

Within OBPR, research in support of Human Support Technology (HST) focuses primarily on addressing the following organizing question:

What technology must we create to enable the next explorers to go beyond where we have been?

Research in Human Support Technology includes the following areas: Environmental Monitoring and Control; Advanced Life Support; Space Human Factors Engineering; Extra Vehicular Activity (EVA) Systems; Fire Research, Detection, and Suppression; EVA/Human-Robotic Integration; and In-Situ Fabrication and Repair. It also addresses the following specific questions, as stated in the OBPR research plan:

- How can we change spacecraft systems to lessen the required up-mass, volume, power, and crew time?
- How can technology help human productivity and well-being during extended isolation from Earth?
- How can we ensure that a crew is living in a safe and comfortable environment?
- What is the optimal way to support environmental health for crewmembers of space flights?

Special emphasis is placed on technology that will have a dramatic impact on the reduction of required mass, power, volume, and crew time and on increased safety and reliability.

This NASA Research Announcement (NRA) solicits basic research and other research that enables technology development in support of specific aspects of Human Support Technology.

Proposals submitted in response to this Announcement must address the research emphases defined in Appendix A of this NRA. *This announcement represents a unique proposal solicitation with particular needs for specific kinds of proposals in specific areas of emphasis. Therefore, it is critical that potential applicants carefully read the Areas of Research Emphasis descriptions in Appendix A of this announcement.* Those proposals that do not address research areas within the scope of HST will be returned to the proposers. Other Announcements calling for focused research or utilization of unique resources may be issued throughout the year. Unsolicited proposals received at other times during the year will be held until the next annual review period if the proposed research is relevant to the programs described in this Announcement. However, NASA reserves the right to act in the best interest of the Federal Government in the matter of proposal acceptance and evaluation.

B. Support of Education and Outreach

OBPR envisions that the selected proposals will be structured and operated in a manner that supports the nation's educational initiatives and goals (including support of historically black colleges and universities and other minority universities), in particular the need to promote

scientific and technical education at all levels. OBPR envisions that the selected proposals will support the goals of public awareness and outreach to the general public. The selected principal investigators are invited to participate in OBPR-funded educational programs.

The educational program represents an opportunity for NASA to enhance and broaden the public's understanding and appreciation of the value of OBPR research in the context of NASA's mission. Individuals participating in NASA's OBPR programs have a responsibility to foster the development of a scientifically informed public. Therefore, all investigators are strongly encouraged to promote general scientific literacy and public understanding of OBPR research through formal and/or informal education opportunities. If appropriate, proposals should include a clear and concise description of the education and outreach activities proposed. Examples include such items as involvement of students in the research activities, technology transfer plans, public information programs that will inform the general public of the benefits being gained from the research, and/or plans for the incorporation of scientific results obtained into educational curricula consistent with educational standards.

Where appropriate, the supported institution will be required to produce, in collaboration with NASA, a plan for communicating to the public the value and importance of their work.

Once NRA selections are made, the selected Principal Investigators (PIs) will have an opportunity to request additional funding through an OBPR-sponsored pilot program to implement an education outreach program at the grades 6-12 level, at an amount not to exceed \$10,000 per year for the term of the grant or cooperative agreement. A request for proposal will accompany the selection notification letter. Proposals will be due within 60 days of selection notification and shall be limited to 4 pages. A review of these proposals by educational specialists will determine which proposals will be funded.

C. NASA Safety Policy

Safety is NASA's highest priority. Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including employees working under NASA award instruments), and (4) high value equipment and property. All research conducted under NRA auspices shall conform to this philosophy.

D. Availability of Funds for Awards

Funds are not currently available for awards under this announcement. The Government's obligation to make award(s) is contingent upon the availability of the appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this announcement.

II. AWARD INFORMATION

Solicited proposal types include ground-based research and development (in both the Biological and Fluid Physics research areas) and ground-based Pilot Studies (Biological Research for Human Support Technology only); these are detailed in Appendix A. Selected proposals for ground-based research will be funded in one-year increments for activities lasting up to **three years**. Selected Pilot Studies will receive Phase I funding for a period lasting up to **12 months**. The funding duration will depend on proposal requirements, review panel recommendations, and continuing progress of the activity. The mechanism for funding the successful proposal will be a single grant or cooperative agreement, with funding allocations to participating investigators based on the submitted budget and project review. The funding duration will depend on proposal requirements, review panel recommendations, and continuing progress of the activity. All proposals will be evaluated for overall merit by independent peer review panels; additional reviews for NASA relevance and proposed cost will be conducted by the appropriate NASA program office. NASA reserves the right to “partner” research projects that it determines will augment one another, with the consent of the offerors. (See Section IV. A.)

It is anticipated that a typical award for ground-based biological research will average approximately \$175-200K per year in total costs. A typical award for ground-based fluid physics research will average approximately \$110-120K per year in total costs. Support for Pilot Studies in biological research will be approximately \$100K per study for Phase I funding. Proposals for awards substantially greater than these amounts must provide adequate justification. NASA reserves the right to return proposals, without review, that exceed the described award amounts. NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget. It is estimated that the initial selection will be announced by **February 2005** and the grant or cooperative agreement awarded in a reasonable time frame.

Principal Investigators holding previous awards selected through any of the programs offered through this NRA are encouraged and welcomed to submit renewal proposals that seek to continue a previously-funded line of research. Similarly, proposals that were submitted to, but not selected under, a previous OBPR solicitation may be submitted as revised proposals. Please see Section IV. B. for detailed requirements regarding submission of renewal or revised proposals.

Awards made through this NRA may be in the form of grants, cooperative agreements, or intra- or inter-Government transfers depending on the nature of the submitting organization and/or specific programmatic requirements. A NASA grants/contracting officer will determine the appropriate award instrument for the selections resulting from this solicitation. Grants and cooperative agreements will be subject to the provisions of the *NASA Grants and Cooperative Agreement Handbook* (hereafter referred to as the *Handbook*, found at <http://ec.msfc.nasa.gov/hq/grcover.htm>).

III. ELIGIBILITY OF APPLICANTS

A. Eligible Applicants

All categories of U.S. and foreign (See paragraph C. below) institutions are eligible to submit proposals in response to this NRA. Principal Investigators may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology, or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior NASA support of research or training in any institution or for any investigator is not a prerequisite to submission of a proposal nor does it confer an inherent advantage or disadvantage in the selection process. Note, however, that NASA-funded PIs are expected to show appropriate evidence of progress and publications resulting from their previous or current NASA funding.

B. Cost Sharing or Matching

If an institution of higher education, hospital, or other non-profit organization wishes to receive a grant or cooperative agreement, cost sharing is not required. However, NASA can accept cost sharing if it is voluntarily offered (See the Handbook, Section B, Provision 1260.123, “Cost Sharing or Matching,” which describes the acceptable forms of cost sharing). If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required unless the commercial organization can demonstrate that they are unlikely to receive substantial compensating benefits for performance of the work. If no substantial compensating benefits are likely to be received, then cost sharing is not required but can be accepted (See the Handbook, Section D, Provision 1274.204, “Costs and Payments”).

C. Guidelines for International Participation

Participation by non-U.S. organizations is allowed, subject to NASA’s Policy of no-exchange-of-funds. Further information on foreign participation, including specific submission requirements, is provided in section (I) of appendix B in the *NASA Guidebook for Proposers* (see Section IV.A. below for location reference).

Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation. Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not be limited to, whether or not the foreign participation may require the prospective investigator to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss

whether the license has been applied for or if not, the projected timing of the application, and any implications for the schedule. Information regarding U.S. export regulations is available at <http://www.pmdtc.org/> and <http://www.bis.doc.gov/>. Investigators are advised that, under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered “Defense Articles” on the United States Munitions List and are subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

IV. PROPOSAL AND SUBMISSION INFORMATION

A. Source of Application Materials

All information needed to apply to this solicitation is contained in this announcement and in the companion document entitled “NASA Guidebook for Proposers Responding to NASA Research Announcements – 2004 ” (hereafter referred to as the Guidebook for Proposers), located at <http://www.hq.nasa.gov/office/procurement/nraguidebook/>. This solicitation and any modifications or updates to this solicitation are available at: http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.

Except where specifically stated otherwise in this NRA, applicants must prepare proposals in accordance with the Guidebook for Proposers. Proposals that do not conform to the standards outlined in this NRA and included in the Guidebook for Proposers may be declared noncompliant and returned without review. Comments and suggestions of any nature about the Guidebook for Proposers are encouraged and welcomed: they may be directed at any time to Mr. Tom Sauret, Office of Procurement, Code HK, NASA Headquarters, 300 E Street SW, Washington, DC 20546-0001; E-mail: tsauret@mail.hq.nasa.gov.

The following information is specific to this NRA and **supersedes** the information contained in the Guidebook for Proposers.

B. Content and Form of Proposal Submission

1. SYS-EYFUS Registration

SYS-EYFUS is an electronic system used by NASA Headquarters to manage research solicitation activity, plan for the receipt of research proposals, track the receipt and peer evaluation of these proposals, and manage funded research (grants, cooperative agreements, etc.).

The SYS-EYFUS Help Desk is available at (202) 479-9376. Help desk hours are from 8 a.m. to 6 p.m. Eastern time.

All investigators planning to submit a proposal to this solicitation are required to register online with SYS-EYFUS. Comprehensive help, instructions, and contact information are provided online. SYS-EYFUS can be accessed at the following Web address:

<http://proposals.hq.nasa.gov/proposal.cfm>

If you have previously registered with SYS-EYFUS, you are asked to verify and update your user information. If you have forgotten your user ID or password, select the “Forgot Your Password” option and type in your first and last name to search our database. The system will send an automatic e-mail message with your username and password to the e-mail address listed in our database.

2. Instructions for Preparing and Electronically Submitting a Notice of Intent

All investigators planning to submit a proposal in response to this solicitation are requested to submit a **non-binding** notice of intent to propose (NOI) by the due date identified in Section IV. C. of this NRA. NOIs are to be submitted via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above and select “New Notice of Intent.”
- 2) The Division Specific Opportunities screen will appear. In the selection window, highlight “**UU-OBPR**” and click on “Continue.”
- 3) The List of Existing Opportunities screen will appear. In the selection window, highlight “**NNH04ZUU004N Biological and Fluid Physics Research for Human Support Technology**” and then click on “Continue.”
- 4) This will bring you to the Notice of Intent Submission Form. **All fields are required.**
 - a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.
 - b. For the proposal type field on this form, please select from **only** the following options:
 - Ground-New/No Prior Support
 - Ground-New/Prior Support
 - Ground-Revised
 - Pilot Study- New/No Prior Support
 - Pilot Study- New/Prior Support
 - Pilot Study-Revised

“Ground” and “Pilot Study” refer to the proposal types described in Appendix A of this NRA. New/no prior support means that the investigator **has not** received NASA funding from 2001 through 2003, new/prior support means that the investigator **has** received NASA funding between 2001 and 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.

- 5) Click on “Submit NOI Page.”
- 6) The Team Member Page screen will appear, where you can add or remove team members. Select “Continue” if there are no other team members. To add a team member, highlight the role option on the selection list, type in the first and last name, and click on search. When the resulting set appears, choose the appropriate radio button and click on ADD to add the person to the NOI. After you are done, click on “Continue.” **IMPORTANT:** If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.
- 7) After continuing from the Team Members Page, your NOI will be displayed. Click on “Resubmit NOI Page” to complete your NOI submission.
- 8) You may edit and resubmit your NOI at any time before the submission deadline. Once you submit an NOI, it cannot be deleted, only edited. For title, team member, or any other changes, please edit your existing NOI and resubmit changes to avoid duplicate records.

3. Instructions for Preparing and Electronically Submitting a Proposal Cover Page

All investigators planning to submit a proposal in response to this solicitation must submit proposal cover page information electronically (online) and provide hard copies of the cover page attached to each proposal copy by the due date indicated in the Summary and Supplemental Information Section of this NRA. The proposal cover page can be submitted and printed via the Web at the following address:

<http://proposals.hq.nasa.gov/proposal.cfm>

- 1) Login to SYS-EYFUS at the URL listed above.
- 2) To submit a New Proposal Cover Page, click the “New Proposal Cover Page” option on the SYS-EYFUS Options screen, and the New Proposals Cover Page screen will appear.

- 3) If you previously submitted an NOI in response to this solicitation, choose to carry over the existing NOI. This option will populate the cover page fields with the NOI information. Edit the information as necessary, click “Continue,” and proceed to #8 below.
- 4) If you did not previously submit an NOI, click on New Proposal Cover Page option, and the Division Specific Opportunities screen will appear.
- 5) In the selection window, highlight “**UU-OBPR**” and click on “Continue.”
- 6) The List of Existing Opportunities screen will appear. In the selection window, highlight “**NNH04ZUU004N Biological and Fluid Physics Research for Human Support Technology**” and then click on “Continue.”
- 7) This will bring you to the Proposal Cover Page Submission Form. Fill in all the fields. All fields are required.
 - a. The proposal summary should be a succinct and accurate description of the proposed work when read separately from the project description. The summary should contain a brief description stating the specific aims of the proposed work. Describe concisely (300-500 words) the research design and methods for achieving these aims.
 - b. For the proposal type field on this form, please select from **only** the following options:
 - Ground-New/No Prior Support
 - Ground-New/Prior Support
 - Ground-Revised
 - Pilot Study- New/No Prior Support
 - Pilot Study- New/Prior Support
 - Pilot Study-Revised

“Ground” and “Pilot Study” refer to the proposal types described in Appendix A of this NRA. New/no prior support means that the investigator **has not** received NASA funding from 2001 through 2003, new/prior support means that the investigator **has** received NASA funding between 2001 and 2003, and revised means that the proposal is a revised version of a proposal submitted to NASA and reviewed from 2001 through 2003, but not funded. A proposal previously submitted but not funded should be identified as being “revised” even if the original Principal Investigator has changed.

- c. Indicate the status of Institutional Review Board (IRB) or Institutional Animal Care and Use Committee (IACUC) approval for your proposal. If your IRB or IACUC review is unavoidably delayed beyond the submission of the application, enter “Pending” on the Proposal Cover Page, and be advised that the certification

must be received within 90 days after the due date for which the application is submitted.

- d. Provide your Data Universal Numbering System (DUNS) and Commercial And Government Entity (CAGE) numbers. If you do not know your DUNS and CAGE numbers, contact your Office of Sponsored Research or equivalent office. All applicants must provide the Dun and Bradstreet (D&B) DUNS number for their organization in the Cover Page of their proposal. This requirement applies to renewals of awards as well as to prospective new awards. The DUNS number is a unique nine-character identification number provided by the commercial company Dun & Bradstreet (D&B). Organizations will use the same DUNS number with every proposal submitted for a Federal grant and cooperative agreement. Note that the DUNS number is site-specific. Applicants may call D&B at 1-866-705-5711 to register and obtain a DUNS number, or access the D&B website at: <http://www.dnb.com/us/>.

NASA also requires the applicant's organization to be registered in the Central Contractor Registration (CCR) database and obtain a CAGE code prior to submitting a proposal. The purpose of this requirement is to help centralize information about grant recipients and provide a central location for grant recipients to change organizational information. Information for registering in the CCR and online documents can be found at <http://www.ccr.gov/>. Before registering, applicants and recipients should review the Central Contractor Registration Handbook, which is also located at <http://www.ccr.gov/>. The process for obtaining a CAGE code is incorporated into the CCR registration.

Click on "Continue."

- 8) The Team Member Page screen will appear, where you can add or remove team members. Every proposal must specify the critically important personnel who are expected to play a significant role in the execution of the proposed effort and their institution of employment. Categories of personnel to be included as Team Members are described in Guidebook for Proposers.

You must include your authorizing official as a team member. When you complete and print the proposal cover page, you will see signature blocks both for yourself and your authorizing official. You are required to submit one original signed (by both you and your authorizing official) cover page with your proposal hardcopies.

IMPORTANT: If the team member is not listed in our database, please have them add themselves as a new user to the system. You may then add them to your team member list.

- 9) After continuing from the Team Member Page, the Proposal Options Page appears.

- 10) Please fill out the budget form by clicking on the “Budget” button, filling in project costs, and clicking “Continue.” This will bring you to the Proposal Budget Review Page. Click “Continue” if the information is correct.
- 11) After verifying your budget information, you will be returned to the Proposal Options Page. Click the “Show/Print” button.
- 12) For detailed budget information, you must use the budget forms provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html. Sample copies of these forms are also available in Appendix B of this NRA and must be filled out for each year of grant support requested. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.
- 13) At the page entitled Proposal Information Item List, click “Continue” to preview your Proposal Cover Page. Print the cover page from your Internet browser once you have reviewed the information. The cover page must be signed by both the Principal Investigator and the authorizing official and attached to the front of your proposal before submission of hard copies to NASA.

By signing and submitting the proposal identified on the cover sheet, the authorizing official of the proposing institution (or the individual investigator if there is no proposing institution) 1) certifies that the statements made in the proposal are true and complete to the best of his/her knowledge; 2) agrees to accept the obligations to comply with NASA Award terms and conditions if an award of a grant or cooperative agreement is made as a result of this proposal; and 3) provides certification to the following: (i) Certification Regarding Debarment, Suspension, and Other Responsibility Matters, (ii) Certification Regarding Lobbying, and (iii) Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs.

Once you print your cover page, the electronic portion of your NASA proposal submission is complete.

- 14) You may edit and resubmit your proposal cover page at any time before the submission deadline as indicated in the Summary and Supplemental Information Section of this NRA. Please note that once you submit a proposal cover page, it can only be edited, not deleted. For title, team member, budget or any other changes, please edit your existing proposal cover page and resubmit changes to avoid duplicate records. After you print your edited cover page, your changes are automatically submitted to NASA.

4. Instructions for Preparation of Proposals

All proposals submitted must include the completed cover page form as described above. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the cover page form, where fields are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of

performance may be for any duration up to the maximum duration identified in the Announcement section of this NRA, but should be suitable for the project proposed.

The proposal must include the following material, in this order:

- (1) Proposal Cover Page: Solicited Proposal Application, including certification of compliance with U.S. code (if applicable). One signed original required. Please see “Instructions for Preparing and Electronically Submitting a Proposal Cover Page” in Section IV.B.3 above for instructions on how to complete the proposal cover page information.
- (2) Transmittal Letter or Prefatory Material, if any (see Guidebook for Proposers).
- (3) Proposal Title Page, with Notice of Restriction on Use and Disclosure of Proposal Information, if any (see Guidebook for Proposers).
- (4) Statement of Justification: A one-page justification on how the proposed research satisfies the unique requirements of OBPR in general and the research emphases of this NRA in particular. The justification should include reference to relevant risks identified in the Critical Path Roadmap that the proposed research might mitigate. The Critical Path Roadmap is available at: http://research.hq.nasa.gov/code_u/bcpr/index.cfm. (Follow the links to the appropriate discipline area.)
- (5) Project Description: The length of the Project Description section of the proposal cannot exceed 20 pages using regular (12 point) type. Text must be printed on one side only and should have the following margins: left = 1.5”; right, top, and bottom = 1.0”. Referenced figures must be included in the 20 pages of the Project Description. The Bibliography, Management Approach, and all following sections are not considered part of the 20-page project description. Proposals that exceed the 20-page limit for the project description will not be reviewed. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with current resources and the resources requested. In addition, the proposal should clearly indicate the relationship between the proposed work and the research emphases defined in this Announcement. Reviewers are not required to consider information presented as appendices or to view and/or consider Web links in their evaluation of the proposal.

New applications when the investigator has received NASA funding in related fields from 2001 through 2003: Results and evidence of progress of the associated NASA supported research must be presented as part of the project description. See the Guidebook for Proposers for details.

Revised applications (revisions of 2001, 2002 or 2003 submissions) must be so designated on the proposal cover page and explained in the project description. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description**, and is in addition to the 20 pages allowed for the

project description. Related changes to the research plan should be highlighted in the body of the project description. Changes within the proposal may be highlighted by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. Revised applications that do not address the criticisms in the previous review will be considered non-compliant and will be returned without review. See the Guidebook for Proposers for additional information.

- (6) Management Approach: Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal must clearly and unambiguously state whether these key personnel have reviewed the proposal and endorsed their participation.

Co-Principal Investigators are not permitted, with the sole exception being when a non-U.S. Co-Investigator is proposed. This exception is described in the Co-Investigator subcategories below.

Investigators are strongly encouraged to identify only the most critically important personnel to aid in the execution of their proposals. Should such positions be necessary, Co-Investigators (Co-Is) may be identified who are critical for the successful completion of research through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, regardless of whether or not they receive compensation under the award. Most NRAs require a Co-I to have a well-defined role in the research that is defined in the Management section of the proposal. Evidence of a Co-I's commitment to participate is often requested through a brief letter to be included with the proposal.

There are three subcategories of Co-Is that a proposal may identify, as appropriate:

- A Co-I may be designated as the *Science PI* for those cases where the proposing institution does not permit that individual to formally serve as the PI as defined above. In such a case, the Science PI will be understood by NASA to be in charge of the scientific direction of the proposed work, although the formally designated PI is still held responsible for the overall direction of the effort and use of funds.
- A Co-I may be designated as an *Institutional PI* when their institution is making a major contribution to a proposal submitted by a PI from another institution.
- A Co-I from a non-U.S. institution may be designated as a *Co-Principal Investigator* (Co-PI) should such a designation serve required administrative purposes in that Co-I's institution and/or for the procurement of funding by that Co-I from their sponsoring funding authority.

Additional category positions are often included in proposals as defined as follows:

- A *Postdoctoral Associate* holds a Ph.D. or equivalent degree and is identified as a major participant in the execution of the proposed research. Such personnel may be identified by name or only by function in those cases where their recruitment depends on the successful selection of the proposal.
- *Other Professional* is a description appropriate for personnel who support a proposal in a critical albeit intermittent manner, such as a consulting staff scientist or a key Project Engineer and/or Manager who is not identified as a Co-I or Postdoctoral Associate.
- A *Graduate Student* included in a proposal is working for a post-graduate degree and will support the proposed research under direction of the PI. Such a student may be identified by name or only by function in case their recruitment depends on the successful selection of the proposal.
- A *Collaborator* is an unfunded position included in a proposal, whose participation is less critical than a Co-I, but who is committed to provide a specific contribution to the proposal

(7) Personnel/Biographical Sketches: The biographical sketch for each investigator should not exceed two pages. If the list of qualifications and publications exceeds two pages, select the most pertinent information. List, in chronological order, the titles, all authors, and complete references to all publications pertinent to this application (see Guidebook for Proposers). A sample biographical sketch form can be downloaded at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html. A sample copy of the form is available as an attachment to this NRA. These forms cannot be electronically submitted. Omit social security numbers and other personal items that do not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described. Fill out the forms and attach them to your proposal.

(8) Facilities and Equipment: Describe the available facilities and major items of equipment specially adapted or suited to the proposed research activities, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use in the research activities. The research plan must provide evidence that such facilities or equipment will be made available if the proposal is accepted. Before requesting a major item of capital equipment, the proposer should determine the availability of equipment already within the organization as an alternative to purchase. Where such arrangements cannot be made,

the proposal should state this explicitly. The need for items that can be typically used for research and non-research purposes should be explained.

- (9) Special Matters (specific information on animal or human subjects protocol approval required, if applicable): For proposals employing human subjects and/or animals, assurance of compliance with human subjects and/or animal care and use provisions is required on the Proposal Cover Page. In addition, the application must include a statement from the applicant institution certifying that the proposed work will meet all Federal and local human subjects requirements and/or animal care and use requirements.

Policies for the protection of human subjects in NASA sponsored research projects are described in NASA Management Instruction (NMI) 7100.8B (*Protection of Human Research Subjects*). Animal use and care requirements are described in the NASA Code of Federal Regulations (CFR) 1232 (*Care and Use of Animals in the Conduct of NASA Activities*). Both documents are available from the Office of Biological and Physical Research, Code UB, NASA Headquarters, Washington, DC 20546.

Additional Requirements for Research Employing Human Subjects

A letter signed by the Chair of the Institutional Review Board (IRB) identifying the proposal submitted to NASA by title and certifying approval of proposed human subjects protocols and procedures should be included with each copy of the proposal. IRB certifications for other research proposals or grants cannot be substituted, even if they employ the same protocols and procedures.

If IRB certification is pending on the proposal due date, select “pending” from the IRB/IACUC section menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IRB Chair identifying the proposal by title and indicating the status of the IRB review process at the time of submission. IRB certification must be received no later than 90 days after the proposal due date. An application lacking the required IRB certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

With regard to research involving human subjects, NASA has adopted the National Institutes of Health (NIH) policy. Women and members of minority groups and their subpopulations must be included in NASA-supported biomedical and behavioral research projects involving human subjects, unless a clear and compelling rationale and justification is provided showing that inclusion of these groups is inappropriate with respect to the health of the subjects or the purpose of the research.

NASA will require current IRB certification prior to each year’s award.

Additional Requirements for Research Employing Animals

Specific information describing and justifying the use of animal subjects must be included in the proposal.

A letter signed by the Chair of the Institutional Animal Care and Use Committee (IACUC) identifying the proposal submitted to NASA by title and certifying approval of the proposed animal research protocols and procedures should be included with each copy of the proposal. The institution's Public Health Service Animal Welfare Assurance Number must be included on the IACUC certification and entered in the IRB/IACUC section of the Proposal Cover Page. IACUC certifications for other research proposals or grants cannot be substituted, even if they employ the same protocols and procedures.

If IACUC certification is pending on the proposal due date, select "pending" from the IRB/IACUC selection menu on the Proposal Cover Page, and include with each copy of the proposal a letter signed by the IACUC Chair identifying the proposal by title and indicating the status of the IACUC review process at the time of submission. IACUC certification must be received no later than 90 days after the proposal due date. An application lacking the required IACUC certification 90 days after the proposal due date will be considered incomplete and may be returned to the applicant without review.

NASA will require current IACUC certification prior to each year's award.

- (10) Proposers are encouraged to make limited use of hazardous, toxic, ozone depleting, and nuclear materials to reduce the potential for environmental risks during their research and to reduce the overall environmental risk when new technologies or methodologies are deployed on future missions. Such steps will enable NASA to better fulfill its mission of understanding and protecting the Earth. Information about use of such materials will be required in order to assist in the environmental review of the proposed research. The grant process will require demonstrated compliance with all applicable Federal, State, Tribal, and local environmental, health, and safety laws.
- (11) Detailed Budget and Supporting Budgetary Information: For detailed budget information, you must use the forms provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html. Sample copies of these forms are also available as attachments to this NRA. These forms cannot be electronically submitted. Fill out the forms and attach them to your proposal.

NASA is operating on the basis of full cost accounting, including all Civil Service salaries with overhead. NASA Centers must propose budgets based on Full Cost Accounting (FCA). Non-NASA U.S. Government organizations should propose based on FCA unless no such standards are in effect; in that case, such proposers should follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board (for further information, see <http://www.hq.nasa.gov/fulcost/>).

If travel is planned, the proposal budget should include appropriate travel funds for visits to NASA field centers (as appropriate) and presentation of findings at professional society meetings.

In this solicitation, the terms “cost” and “budget” are used synonymously. Sufficient proposal cost detail and supporting information are required; funding amounts proposed with no explanation (e.g., Equipment: \$1,000, or Labor: \$6,000) may cause delays in evaluation and award. Generally, costs will be evaluated for realism, reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines; hours and rates should be estimated for each. Estimates should include a basis of estimate, such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means, including comparison to similar skills at other organizations.

Other Direct Costs

Please detail, explain, and substantiate other significant cost categories as described below:

- Subcontracts: Describe the work to be contracted, estimated amount, recipient (if known), and the reason for subcontracting.
- Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and the rates of pay.
- Equipment: List separately. Explain the need for items costing more than \$5,000. Describe basis for estimated cost. General-purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested as a direct charge must include the equipment description, how it will be used in the conduct of the basic research proposed, and why it cannot be purchased with indirect funds.
- Supplies: Provide general categories of needed supplies, the method of acquisition, and estimated cost.
- Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers (if known).
- Other: Enter the total of direct costs not covered by a) through e). Attach an itemized list explaining the need for each item and the basis for the estimate.

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current

variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as “application base equals total costs before G&A less subcontracts”.

All awards made as a result of this NRA maybe funded as grants or cooperative agreements. However, while proposals submitted by “for profit” organizations are allowed, they cannot include a “fee.”

(12) Other Support: You must provide information on other support for specific sources of other support for the principal investigator and each Co-Investigator (not consultants). A form is provided at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html. A sample copy of the form is also available as attachment to this NRA

(13) Appendices, if any (**reviewers are not required to consider information presented in appendices**).

C. Submission Dates and Times

One (1) signed original cover page and proposal and twenty (20) copies of the proposal cover page and proposal **must be received by 4:30 p.m. Eastern time on September 29, 2004**. Proposals shall not be submitted electronically, except for parts specified in this NRA. Proposals mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

NASA Peer Review Services
SUBJECT: HST NRA
500 E Street SW
Suite 200
Washington, DC 20024

Proposals that are hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between 8:00 a.m. and 4:30 p.m. Proposals must be received by 4:30 p.m. Eastern time on the proposal due date. The telephone number, (202) 479-9030, may be used when required for reference by delivery services. NASA Peer Review Services (NPRS) cannot receive deliveries on Saturdays, Sundays, or Federal holidays. NPRS will send notification to the investigator confirming proposal receipt within 5 business days of the proposal receipt date; however, there will not be a response from the Office of Biological and Physical Research.

The following items apply only to this Announcement:

Solicitation Announcement Identifier:	NRA NNH04ZUU004N
Number of Copies Required:	1 Signed Original + 20 copies
Notices of Intent Due:	July 29, 2004
Proposals Due:	September 29, 2004
Estimated Selection Announcement:	February 2005
Selecting Officials:	Directors, Bioastronautics Research Division Fundamental Space Biology Division Physical Sciences Division Office of Biological and Physical Research

D. Funding Restrictions

- The construction of facilities is not an allowed activity unless specifically stated so in the program description. For further information on the allowability of costs, refer to the cost principles cited in the Guidebook for Proposers.
- Travel, including foreign travel, is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for publicizing its results at an appropriate professional meeting. The proposal must include travel funds for an annual Investigators Meeting.
- U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources, but award funds may not be used to fund research carried out by non-U.S. organizations. However, subject to possible export control restrictions, foreign nationals may conduct research while employed by a U.S. organization.
- NASA does not provide separate funding for direct and indirect costs; thus, the amount of the award requested is the total of all costs submitted in the proposed budget.
- Regardless of whether functioning as a team lead or as a team member, personnel from NASA Centers must propose budgets based on Full Cost Accounting (FCA). Non-NASA U.S. Government organizations should propose based on FCA unless no such standards are in effect; in that case such proposers should follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board (for further information, see <http://www.hq.nasa.gov/fullcost/>).

V. PROPOSAL REVIEW INFORMATION

The following information is specific to this NRA and **supersedes** the information contained in the Guidebook for Proposers.

A. Merit Review Evaluation Criteria

The evaluation process for this NRA includes a review for Intrinsic Scientific or Technical Merit (merit review) as well as reviews for Feasibility of Implementation, Relevance, and Cost. The most important factor in the evaluation process is the merit review, which carries the highest weight in final evaluation and selection. The other reviews considered in the evaluation process are approximately equal in weight to each other; however, numerical scores are not assigned for these reviews. **Deficiencies in any one of these factors may prevent selection of a proposal.**

The following merit review criteria are used in assigning the merit score; however, review panels are given considerable latitude in integrating the evaluation of these criteria into a final merit score.

- **Innovation:** Does the project employ novel concepts, approaches, or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technology?
- **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods, or products that drive this field?
- **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics? Is the proposal high-risk and high-payoff? Is it likely that the proposed implementation timeline will be met?
- **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
- **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

Section V.B.2. of this announcement details all phases of the review (i.e., Merit Review, Feasibility of Implementation, Relevance, and Cost) as well as the selection process.

B. Review and Selection Process

1. Compliance Matrix

All proposals must comply with the general requirements of the Announcement as described in both this solicitation and the Guidebook for Proposers. Upon receipt, proposals will be reviewed for compliance with the requirements of this announcement. This includes:

1. Submission of complete proposals specified in this Announcement. Proposals must be responsive to the areas of program emphasis described in this Announcement and must include a project description that is not more than 20 pages (i.e., 20 sides) in length.
2. Submission of appropriate Institutional Review Board (IRB) or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects.
3. Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding that described in the Announcement.
4. Proposals that are revised versions of proposals previously submitted to NASA must be clearly designated as such on the proposal cover page and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review. This explanation should be presented in a separate section of **no more than two pages at the beginning of the project description** and is in addition to the 20 pages allowed for the project description. Related changes to the research plan should be highlighted in the body of the project description.
5. Submission of all other appropriate information as required by this NASA Research Announcement and the Guidebook for Proposers.

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the investigator without further review.

Compliant proposals submitted in response to this Announcement will undergo an intrinsic scientific or technical merit review. Only those proposals most highly rated in the merit review process will undergo additional reviews for program relevance and cost.

2. Review and Selection Process

Merit Review

The first review tier will be a review of intrinsic scientific or technical merit by a panel of scientific or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Appendix A of this NRA. The merit review panel will assign *a score from 0-100* based upon the merit review criteria detailed in Section V.A. of this NRA. This score will reflect the consensus of the panel.

The score assigned by this panel *will not be affected by the cost of the proposed work, nor will it reflect the programmatic relevance of the proposed work to NASA*. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the

proposal's budget, relevance to NASA, and (for Fluid Physics proposals only) microgravity relevance.

Feasibility of Implementation Review

*This review will be conducted only for the most highly rated proposals from the **merit** review.*

The Feasibility of Implementation Review will be conducted, appropriate to the TRL level of the research proposed, by a scientific or engineering and technical review team assembled by NASA. For Pilot Studies, Feasibility of Implementation will look for potential critical problems evident in the ideas themselves which could render the research unfeasible for use by NASA. For longer-term or more mature proposals, evaluation for the feasibility of implementation of the results of the proposed work (i.e., the resulting research results) into an operational NASA system will be conducted. This review team will evaluate the feasibility of implementing the resulting research results using available NASA facilities. Please refer to Section IV of Appendix A for hardware and facilities references.

The purpose of the feasibility of implementation review is to assess the likelihood that the proposed research, if completed successfully, would lend itself to continued research and technology development in the context of the HST goals.

Evaluation of Relevance and Cost

*This review will be conducted only for the most highly rated proposals from the **merit** review.*

The evaluation of programmatic relevance and cost of each proposal will be conducted by NASA program scientists and managers as follows:

- **Programmatic Relevance:** In this context, programmatic relevance is the establishment of the relative priority of proposed projects for HST, based on current needs and considerations of programmatic balance. For example, a proposal with a high merit score for work that is redundant with work already being conducted may be passed over in favor of another proposal with a lower merit score in an area of higher programmatic need. Programmatic relevance evaluation will include the Critical Path Roadmap. The Critical Path Roadmap is available at http://research.hq.nasa.gov/code_u/bcpr/index.cfm (follow the links to the appropriate discipline area).
- **Microgravity Relevance:** *This evaluation is applicable only to Fluid Physics proposals.* Evaluation of the extent to which the proposed research is enabled by the unique characteristics of the microgravity or space environment, or supports research in the space environment.
- **Cost:** Evaluation of the proposed cost includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds.

Development of Selection Recommendations

The information resulting from these levels of review, as described above, will be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the research areas described in this Announcement. This recommendation will be based on:

1. The scientific or technical merit review score from the peer review panel;
2. The results of the feasibility of implementation review; and
3. The programmatic relevance, microgravity relevance (fluid physics proposals only), and cost of each proposal.

This **selection recommendation** is the responsibility of the NASA program scientist(s). Selection for funding will be made by the appropriate selecting official. The Selecting Officials for this NRA are the Directors of the Physical Sciences Research Division, Fundamental Space Biology Division, and Bioastronautics Research Division.

VI. AWARD ADMINISTRATION INFORMATION

A. Award Notices

At the end of the selection process, each proposing organization will be notified of its selection or nonselection status. NASA provides debriefings to those investigators who request one. The selection letters will include a statement indicating that the selected organization's business office will be contacted by a NASA Contracting or Grant Officer, who is the only official authorized to obligate the Government, and a reminder that any costs incurred by the investigator in anticipation of an award are at their own risk. Selection notification will be made by a letter signed by the selecting official and sent by postal mail.

The NASA Procurement Office will determine the type of award instrument, request further business data, negotiate the resultant action, and are the only personnel with the authority to obligate government funds.

NASA may desire (1) to select only a portion of the proposed investigation and/or (2) that an individual proposer team with other proposers in a joint investigation. In these cases, the proposer will be given the opportunity to accept or decline such participation prior to selection.

B. Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or National policy requirements, nor do the award(s) that will be made involve any special terms and conditions that differ from NASA's general terms and conditions.

C. Award Reporting Requirements

1. *Journal Publications*

It is expected that results from funded research will be submitted to peer-reviewed journals as the work progresses. All articles submitted for publication must include the following statement: “This research was funded in whole or in part by a grant from the Office of Biological and Physical Research of the National Aeronautics and Space Administration.” Publications not including this acknowledgement will not be considered to be the product of NASA-funded research when NASA assesses the progress of the grant.

2. *Annual Report*

The Office of Biological and Physical Research publishes a comprehensive online document titled OBPR Program Tasks and Bibliography (Task Book) which includes descriptions of all current peer-reviewed activities funded by the division. Since its inception, the Task Book has served as an invaluable source of information for OBPR as well as the scientific and technical communities.

Investigators are required to provide NASA with this summary information at a minimum of once per year. This information will be made available to the scientific community and will be used to assess the strength of the Division’s programs. It will also serve as the basis for determining the degree of progress of the project. The information provided for the Task Book will meet both the requirements for program annual reporting and the individual researcher task book reporting. Updates can be made throughout the duration of the project at any time during the year, with a due date of at least once per year 60 days prior to the anniversary of the grant start date.

The information requested will include:

- an abstract,
- a brief statement of progress,
- a brief statement of benefits of the research with respect to life on Earth,
- an updated bibliographic list,
- a copy or reprint of each publication listed in the bibliography,
- a listing of presentations or activities conducted at 6-12 educational institutions,
- a listing of interactions, presentations, or other activities with the general public, and
- a statement of potential scientific, technological, economic, or societal impact.

Note that, although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

4. *Annual Investigators’ Meeting*

The PI and/or other participating investigators shall present results of their research annually at an Investigators’ Meeting designated by NASA. These meetings are generally held in winter or spring, and are designed to encourage exchange of information among investigators. Annual

Investigator Meetings may be coupled with other scientific meetings or conferences. Proposed budgets should include travel for these annual meetings.

5. *Final Report*

A final report must be provided to the appropriate Division Director at NASA HQ at the end of the entire funding period, including a detailed listing of all peer-reviewed publications. The final report is required to include the following information:

- summary of the research activities,
- statement of the specific objectives,
- significance of the work,
- background on the work,
- overall progress during the performance period,
- narrative discussion of technical approaches including problems encountered,
- accomplishments related to the approach, and
- an appendix with a bibliography and copies of all publications and reports. Any publications or other public materials containing data are particularly important to include in this section.

VII. NASA CONTACTS AND CONCLUDING STATEMENTS

General questions and comments regarding the policies of this NRA may be directed to:

Charles J. Barnes, Ph.D.
Enterprise Scientist
Office of Biological and Physical Research
NASA Headquarters, Code UB
Washington, DC 20546-0001
Telephone: (202) 358-2365
Fax: (202) 358-4168
E-mail: Charles.J.Barnes@nasa.gov

The NASA point of contact for funding (either a Contracting or Grant Officer) will be specified in each selection notification letter.

VIII. REFERENCES

A. General References

NASA's Office of Biological and Physical Research. NASA, Washington, DC.
<http://spaceresearch.nasa.gov/>

Online Notice of Intent and Proposal Submission. <http://proposals.hq.nasa.gov/proposal.cfm>

Guidebook for Proposers Responding to a NASA Research Announcement (NRA). This document is available online at the following address:
<http://www.hq.nasa.gov/office/procurement/nraguidebook>.

National Aeronautics and Space Administration Strategic Plan. (2000). NASA, Washington, DC. <http://www.hq.nasa.gov/office/codez/plans.html>

NASA's Biological and Physical Research Enterprise Strategy. (2003). NASA, Washington, DC. http://spaceresearch.nasa.gov/general_info/strat.html

OBPR Program Tasks and Bibliography (Task Book) for FY 1995 through FY 2003. Available online at the following address: <http://research.hq.nasa.gov/taskbook.cfm>.

Life sciences research publications. <http://spaceline.usuhs.mil/> and <http://www.nlm.nih.gov/>. Additional information may be obtained from the SPACELINE Project (phone: (301) 295-2482; e-mail: spaceline@usuhs.mil)

Critical Path Roadmap http://research.hq.nasa.gov/code_u/bcpr/index.cfm

Guidelines & Capabilities for Designing Human Missions (2002). NASA Exploration Team Human Subsystem Working Group, National Aeronautics and Space Administration, Johnson Space Center, Houston, Texas.

http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html

Space Life Sciences Ground Facilities Information Package. This document is available online at the following address:
http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html

B. Programmatic References

NASA Science/Technology Plans and Requirements Documents relevant to Human Support Technology in the Office of Biological and Physical Research, NASA, Washington, DC:

Advanced Human Support Technology Program Plan (1999)

Advanced Life Support Project Plan (2002)

Advanced Life Support Requirements Document, JSC-38571B (2002)

Advanced Life Support Technology Assessment Matrix (1998)

Advanced Life Support Metric (2002)

Baseline Values and Assumptions Document (BVAD, 2002)

Unless otherwise noted, the above documents are available online at
http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html

NASA Advanced Life Support Roadmap (1998). Available online at
http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html

C. Other References

Advanced Technology for Human Support in Space. (1997). Report of the National Research Council (NRC) Committee on Advanced Technology for Human Support in Space, Aeronautics and Space Engineering Board (ASEB), National Academy Press, Washington DC (ISBN 0-309-05744-2; 1997) http://research.hq.nasa.gov/code_u/nra/current/NRA-03-OBPR-01/index.html

Assessment of Programs in Space Biology and Medicine. (1991). National Academy of Sciences, National Research Council. Committee on Space Biology and Medicine, National Academy Press, Washington, DC.

Publications of the NASA Controlled Ecological Life Support System (CELSS) Program: 1989-1992. (1994). J.V. Powers (Ed.). NASA Contractor Report 4603.

NASA Strategic Planning Documents. Publications resulting from activities supporting the development of strategic plans and research strategies.

A Strategy for Space Biology and Medical Science into the Next Century. (1998). National Academy of Sciences, National Research Council, Committee on Space Biology and Medicine; Jay M. Goldberg, Committee Chairperson; National Academy Press, Washington, DC.
<http://books.nap.edu/books/0309060478/html/index.html>

RESEARCH OPPORTUNITIES IN SPACE BIOLOGICAL AND PHYSICAL SCIENCES, HUMAN SUPPORT TECHNOLOGY

APPENDIX A: SCIENTIFIC/TECHNICAL DESCRIPTION

I. INTRODUCTION

NASA's Biological and Physical Research Enterprise seeks research proposals in support of Human Support Technology (HST). This Announcement solicits scientific and technical proposals to be funded during fiscal year 2005, either for new research or for the continuation of research beyond the term specified in a previously funded grant.

This Appendix defines the research encompassed by this Announcement, describes the specific areas of research that proposals should address, and describes the specific emphases that are acceptable for submission in response to this Announcement. It is important that the prospective investigator read the relevant section(s) carefully, as some of the programmatic emphases are different from those appearing in previous Announcements. In addition, this NRA includes guidelines for preparing and submitting proposals and defines the administrative policies governing the program and investigators.

This announcement solicits proposals for the following Human Support Technology research areas only:

- Biological Research for Human Support Technology, and
- Fluid Physics Research for Human Support Technology.

In addition to requirements specified in other sections of this NRA, investigators responding to this Announcement for HST will be expected to:

- Include a one-page justification on how the proposed research satisfies the unique requirements of HST in general and the research area in particular. Note that this one-page justification does not count toward the 20-page limit for the Project Description section. The justification should include reference to relevant risks identified in the Bioastronautics Critical Path Roadmap that the proposed research might mitigate. The Bioastronautics Critical Path Roadmap is available online at http://research.hq.nasa.gov/code_u/bcpr/index.cfm (Follow links to appropriate discipline area.)

In fulfilling this requirement, investigators are encouraged to refer also to current Project Plans, Reports, and other relevant background documents. These documents are available at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.

- Establish contact with appropriate NASA field center personnel to determine how the proposed research activity might support development of HST. Contact information for appropriate NASA personnel is provided throughout Section III of this Appendix.

- Discuss (and quantify, if possible) in their proposal the potential benefit of their work to NASA in terms of minimization of mass, power, and crew time used, increased system reliability, safety, or other factors for present or future missions. Investigators are encouraged to refer to the system analysis assumptions as reflected in the Advanced Life Support (ALS) baseline values and assumption document (BVAD) and the discussion of equivalent system mass (ESM) in the ALS Metric. These documents may be found at the following Web site:
http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.
- Assure compliance with federal regulations regarding human subjects and/or animal care as part of the proposal submission process. NASA has a strong commitment to the ethical treatment of human and animal research subjects. Applicants should note that review of proposals involving human or animal research subjects will not be undertaken if the required information is not supplied.

II. TYPES OF PROPOSALS SOUGHT

Each of the HST research areas described in this Announcement has unique needs for specific kinds of proposals in specific areas of emphasis. *Proposals for research in areas outside the specific areas of emphasis listed in this Announcement will likely receive lower priority for funding.*

A proposal may be multidisciplinary or interdisciplinary, involving combinations of these research areas. For such proposals, the teaming arrangements should be clearly stated.

In addition to the overview information listed below, prospective investigators should also carefully read the individual Research Area descriptions in Section III of this Appendix. Investigators also should be aware of the concept of Technology Readiness Levels (TRLs) as it applies to their work (see Figure 1 below).

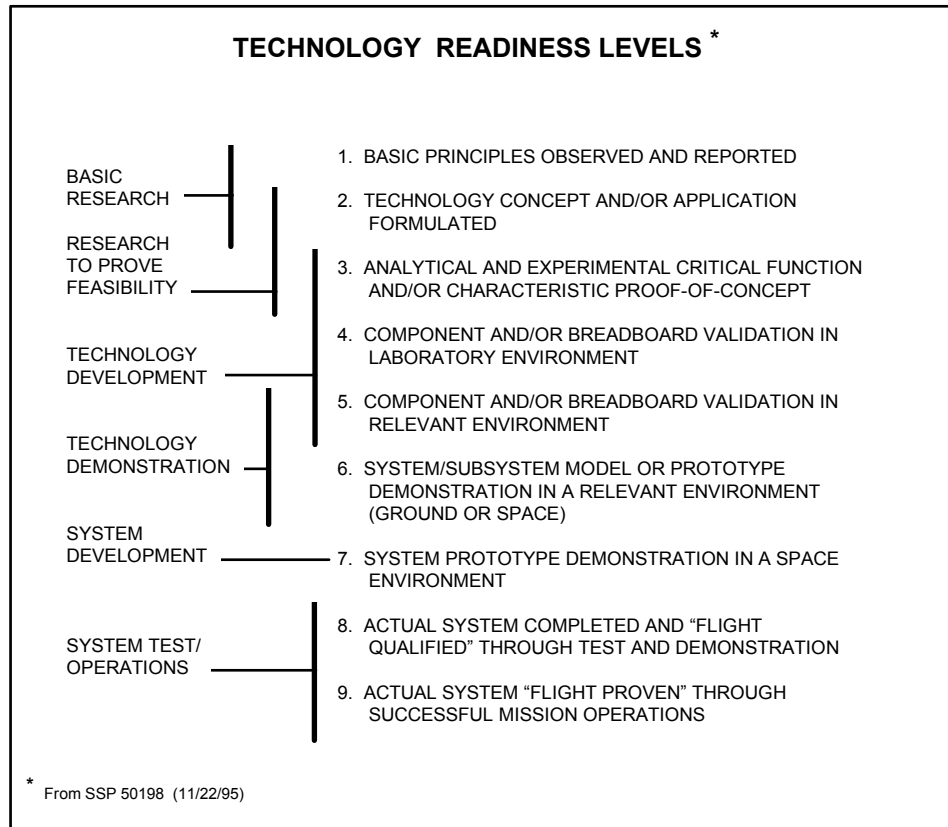


Figure 1. NASA Technology Readiness Levels

Research funded through this NRA must be at TRLs appropriate for the corresponding proposal type as described below (subsections A – D).

A. Pilot Studies (open only for Biological Research for Human Support Technology)

High-innovation, high-risk Pilot Study proposals for research at low TRLs (TRLs 1–2, see Figure 1) are solicited. Pilot Studies are expected to involve highly innovative approaches or explore new research paradigms or concepts that will strongly affect human support technology, even if they are highly speculative or contain a substantial risk of failure. Awards in this category are for no more than 12 months, averaging a total cost of \$100,000, and require attendance at two NASA-lead Principal Investigator (PI) team meetings during the course of funding. If the pilot project is successful, PIs given a Pilot Study award will be expected to form and participate in teams that develop follow-on proposals for longer-term work leading to direct insertion into a NASA HST application.

For the Pilot Study proposal category, the initial 12 months of Phase I funding is envisioned to be the first of two possible phases. Phase I funding does not guarantee Phase II funding; however, Phase I funding is a prerequisite. Phase II will emphasize the integration of Phase I approaches into actual technology development, with a strong emphasis on teaming. Teams will be developed among PIs and/or with NASA investigators. Team development for Phase II will be facilitated through the NASA Headquarters lead and the NASA Technical Monitor for Phase I projects. Teams developed for Phase II projects will be expected to propose within three months

of completion of Phase I. Phase II proposals will be separately evaluated, but will use criteria as described above, with an emphasis placed on probability of successful development of a prototype instrument that can be demonstrated in a relevant environment (i.e., TRL 5–6, see Figure 1) at the end of the three-year Phase II funding period.

To facilitate the overall goal of rapid insertion, the merit review of Pilot Studies will emphasize the Innovation and Significance merit review criteria.

Currently funded HST PIs may contact relevant NASA personnel if interested in participating in future teaming and proposal development.

B. Ground-Based Research (open to both Research Areas)

These are proposals to carry out ground-based biological or fluid physics research relevant to Human Support Technology applications. Typically, these will be for low TRL work (TRL 1–3, see Figure 1) with a clearly defined set of objectives relevant to NASA’s BPR Enterprise goals and addressing one or more of the critical questions in the OBPR Research Plan or the Bioastronautics Critical Path Roadmap (see website at: http://research.hq.nasa.gov/code_u/bcpr/index.cfm). Awards in this category will be for no more than three years and are expected to average no more than \$175-200K per year for biological research and \$110-120K for fluid physics research. Proposals requesting amounts that are significantly above this funding average require substantial justification. For Fluid Physics ground-based research projects selected through this NRA, NASA may, with the cooperation of the investigator, choose to elevate a project to Flight Definition status within the original period of award.

III. AREAS OF RESEARCH EMPHASIS

A. Biological Research for Human Support Technology

Research Area Description

For Human Support Technology, basic and applied research is conducted on biological components and subsystems of the overall life support system to enable long duration human missions in space. Such missions, including increments on the ISS and future Lunar and Mars exploration missions, may last from several months to years. Resupply of life support materials is expensive and becomes increasingly difficult the greater the distance from Earth, necessitating greater efficiency, autonomy, and reliability of the systems and subsystems that enable the mission.

In order to provide biological components and subsystems that will enable the human support technology necessary for long duration missions, research must be undertaken in the following areas:

- Basic biological research to understand the underlying mechanisms that control responses, adaptation, and performance of plants in space environments* at the whole

plant, cellular, molecular, and genomic levels; for example, mechanisms of perception and signal transduction of environmental stimuli;

- Ecological interactions of biological components of life support systems, such as host-pathogen interactions, root zone microbial population dynamics, etc.;
- Integration of biological components and subsystems with each other and with physical/chemical components and subsystems; and
- Applied biological research to improve the efficiency, autonomy, and reliability of the biological components of the life support system by reducing the mass (equivalent system mass), power, volume, and crew time required to provide air, water, food, and waste processing for the crew.

*Space environmental parameters include fractional g forces, reduced atmospheric pressure (including variable CO₂ and O₂ partial pressures), elevated CO₂ levels, high ethylene levels, cosmic radiation, and growth in simulated Lunar or Martian regolith.

Information regarding individual projects currently funded in these areas is available through the OBPR Task Book at <http://peer1.nasaprs.com/search2004/index.cfm>.

In all areas, proposals are sought that will dramatically advance the goals of increasing reliability and autonomy while reducing mass, power, volume, and crew time for the biological components of the life support system. The equivalent system mass (ESM) of the overall life support system serves as a good aggregate measure of life support system performance and is critical in determining the cost of human space flight.

Information about the Advanced Life System Equivalent System Mass (ESM) Metric can be found at http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.

Proposals Sought for FY 2005

For FY 2005, Biological Research for Human Support Technology will emphasize:

Pilot Studies

Pilot Study proposals are solicited that focus on:

- *novel, high-risk innovations for plant water, nutrient, and light delivery and distribution systems that have the potential to effect an order of magnitude reduction on the power, mass, volume, or heat-rejection requirements for plant production and*
- *novel, high-risk molecular approaches that have the potential for order-of-magnitude improvements in the efficiency of bioregenerative subsystems or components.*

The intent and scope of the pilot study proposals, including the organization of the research team, must comply with the description of Pilot Studies detailed in Section II, Part A, of this Appendix.

Ground Research Studies

Ground based research studies are solicited that:

- develop mechanistic knowledge of plant responses to gravity (gravity thresholds, fractional g forces), cosmic radiation, light, and other relevant space environmental factors that enable targeted improvements in plant form, function, and yield via genetic engineering and*
- determine the effects of the space environment (including ionizing radiation) on microbial community function, biofilm development, pathogenicity (frequency or expression), and community stability over multiple generations in closed bioregenerative subsystems.*

NASA Technical Contacts

Questions about the Biological Research for Human Support Technology solicited in this Announcement may be directed to:

Charles J. Barnes, Ph.D.
Enterprise Scientist, Code UB
Office of Biological and Physical Research
NASA Headquarters
300 E Street SW
Washington, DC 20546-0001
Telephone: 202-358-2365
E-mail: Charles.J.Barnes@nasa.gov

B. Michael Lawson
Advanced Life Support Manager
Mail Code: EC
NASA Johnson Space Center
2101 NASA Road One
Houston, TX 77058
Phone: 281-483-9124
E-mail: b.m.lawson@nasa.gov

Raymond Wheeler, Ph.D.
Chief Plant Physiologist
Bioregenerative Life Support
Mail Code: YA-E4-B
Kennedy Space Center
Cape Canaveral, FL
Phone: 321-861-2940
Email: Raymond.M.Wheeler@nasa.gov

For additional information, investigators should refer to the Advanced Life Support Web site at <http://advlifesupport.jsc.nasa.gov/>.

Supporting Documents

Further information about this research area can be found in the following documents:

- Advanced Life Support Project Plan, JSC-39168 (2002)
- Advanced Life Support Requirements Document, JSC-38571B (2002)
- Advanced Life Support Technology Assessment Matrix (1998)
- ALS Roadmap (1998)
- ALS Metric (2002)
- Baseline Values and Assumptions Document, JSC-47804 (2002)
- Advanced Life Support Systems Integration, Modeling and Analysis Reference Missions Document, JSC 39502 Rev.A (2001)
- Advanced Technology for Human Support in Space: NRC Report (1997)

These supporting documents can be accessed via the Internet at the following address:

http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html

B. Fluid Physics Research for Human Support Technology

Research Area Description

In this section of the NRA, OBPR is soliciting research involving low gravity fluid behavior or relevance, to advance technology for **water recovery, air revitalization, thermal control, and environmental monitoring devices** in spacecraft or in habitats on planetary surfaces such as the Moon or Mars. The Fluid Physics research solicited in this Announcement is more focused and less fundamental in nature than Fluid Physics research solicited in previous OBPR Physical Science NRAs. Because of the multidisciplinary nature of human support technology challenges, collaborative research efforts are encouraged.

Water Recovery

Water recovery systems utilize techniques to transform crew and system wastewater into potable water for crew and system reuse. Resultant advances will yield a system that is capable of recycling water at a lower energy and resupply demand. Since many water recovery systems require an understanding of microgravity fluid physics, the past approach has been to avoid two- and three-phase flow. The fluid flow problems in many of the water recovery systems are related to multiphase flow, scale-up, and biofouling.

Air Revitalization

Air revitalization capabilities are required to remove carbon dioxide (CO₂) from the cabin atmosphere, to recover oxygen from the CO₂, and to remove unpleasant or potentially hazardous gaseous atmospheric trace contaminants. Also included is the supply of atmosphere constituent gases; the control of gas partial pressures; cabin ventilation; and removal of particulates, microorganisms, and dust from the cabin atmosphere. Air revitalization opportunities exist to leverage off experiments to be conducted on board the International Space Station (ISS) to better

understand the particulate matter size distribution and continued development of packed beds for carbon dioxide removal.

Thermal Control

The thermal subsystem is responsible for maintaining cabin temperature and humidity within appropriate bounds and for rejecting the collected waste heat to the environment. The thermal control system hardware is categorized in terms of heat acquisition, heat transport, and heat rejection. Thermal control systems on spacecraft typically involve single-phase fluid and heat transfer processes; but the need for improved energy-to-mass ratios is urging a shift towards two-phase operations.

Environmental Monitoring

Advanced environmental monitoring impacts the direct relationship of the environment to astronaut health. The closed spacecraft environment requires careful monitoring for gradual buildup of harmful trace chemicals and microorganisms. Exploration missions will not be able to employ the current practice of returning air and water samples to earth for chemical and microbial testing, and will therefore require on-board monitoring. Many of the monitoring devices that involve the measurement of contaminants in liquid phases will involve management of multiple phases (especially bubbles in a fluid). Air monitoring technology will include management of particulates and humidity in the air stream.

The HST goals are to reduce the mass of current life support systems, consumables, buffer, and instruments/equipment. The Advanced Life Support project is tasked with developing the next generation in life support technology for future missions. The goal is to reduce the equivalent system mass (defined in the ALS Metric supporting document) by a factor of three. This reduction is evaluated within the context of the existing/planned International Space Station (ISS) Environmental Control and Life Support System (ECLSS). The ISS ECLSS provides temperature and humidity control, CO₂ removal, CO₂ reduction (planned), oxygen generation, O₂/N₂ control, potable water procession, urine recovery, waste management, and crew systems (toilet, shower, etc.). For future long duration space missions, life support systems will require not only a high degree of closure of the oxygen and water regeneration loops and effective thermal management, but also a partial closure of the food loop along with the containment and recycling of solid wastes. This will increase the self-sufficiency and, correspondingly, the level of safety of these missions.

In order to reach these goals, fluid physics behavior, such as multiphase flow, thin film stability, degassing of liquids, surface tension directed flow, two phase flow separation, boiling, and condensation in low gravity, needs to be understood to enable the design and successful operation of lower mass systems for air revitalization, water recovery, thermal control, and environmental monitoring in spacecraft or on planetary surfaces.

This research supports experimental and theoretical investigations in ground-based laboratories. NASA ground-based facilities providing low-gravity test times are available via drop towers or research aircraft. Ground-based experiments, along with theoretical modeling, will build on our

current understanding of the effects of gravity on fluid processes and phenomena as it pertains to human support technology. Consequently, the fluid physics research solicited in this Announcement is more focused and less fundamental in nature. The fluid physics investigations fall into the following sub-discipline areas: Multiphase Flow with and without Heat Transfer, and Interfacial Phenomena.

Proposals Sought for FY 2005

Pilot Studies

Pilot Studies are **NOT** solicited for Fluid Physics Research for Human Support Technology. Please refer to Biological Research for Human Support Technology for Pilot Studies solicited through this Announcement.

Ground-Based Research

Multiphase Flow with and without Heat Transfer

Due to relatively large density differences between phases, gravity tends to exert a controlling influence on multiphase flows and phase changes. Microgravity behavior of such systems often differs markedly from normal-gravity behavior. Future advanced concepts for life support in space will most likely rely on multiphase flow and phase change to improve energy to mass ratios. Areas of interest include:

1. Flow Regimes and Regime Transitions: Multiphase flows normally configure themselves into distinctive flow regimes in which the various phases are non-uniformly distributed across the duct through which they flow.
2. Pool and Flow Boiling: Nucleate boiling is one of the most efficient heat transfer mechanisms, not only on Earth but also for space applications where the size and mass of the equipment are critically constrained.
3. Condensation: Condensation removal is important for humidity control and devices such as capillary pumped loops and loop heat pipes.
4. Gas-Liquid Flow through Porous Media: Gas-liquid flow through a fixed bed of particles occurs in some air revitalization and water recovery systems.
5. Liquid-Vapor (gas) Separation: Life support systems (water recycling) operating in space require two-phase flow separators, either active (such as centripetal or cyclone) or passive, in order to function.
6. Dust Flow and Particulate Control: The management and removal of fine particulates and dust agglomeration in gas regeneration and recovery systems for air revitalization must be improved.

NASA engineers have often avoided the use of multiphase systems and processes in spacecraft and satellites because they lack a basic understanding of multiphase flow and heat transfer phenomena in reduced-gravity environments. This has prevented the deployment of efficient and high-power-density active systems that otherwise might have been used for NASA's missions. It is required that we better understand the performance of multiphase systems in space and provide

the basis for the development of accurate computational capabilities. There is a continuing need for experimental microgravity data and appropriate empirical correlations as well, since some physical phenomena and design issues may go beyond current, and anticipated near-term, computational capabilities. Applications in Human Support Technology suitable to the NRA include heat exchangers, condensers, liquid-vapor separators, distillers, boilers, storage tanks, and dust control systems.

Interfacial Phenomena

Understanding the behavior of fluids at a solid-liquid-gas or liquid-gas/vapor interface is not only a subject of scientific curiosity, but also of great technological interest. Many systems, such as packed reactors, degassing of liquids using membranes, microfluidic, and bubble mitigation methods in environmental monitoring devices, rely on the fluid mechanics of the solid-liquid-gas interface. On Earth, gravity tends to overwhelm the effects of surface tension force except in a very thin layer of fluid in the vicinity of the solid-fluid interface. In microgravity, the region influenced by surface tension is magnified considerably, allowing one to probe the characteristics of this region with much greater precision and insight. Areas of interest include:

1. Capillary Phenomena: Earth gravity overwhelms the effects of capillary forces except for a thin layer near the solid-fluid interface. In microgravity, surface tension can control the shapes of liquid bodies of even large scale, leading to configuration changes that can be important in the drainage of storage tanks and fluid handling. Issues involve wetting and capillary behavior.
2. Solid-Liquid Interactions: Contact-line dynamics of fluid-fluid-solid tri-junctions can control coating of solid surfaces, cooling of hot surfaces, and behavior of vapor bubbles in nucleate boiling.
3. Coalescence and Aggregation Phenomena: Numerous phase-separation processes rely on coalescence or aggregation of dispersed phases to form continuous phases. Boiling and condensation are familiar examples.
4. Drops and Bubbles: The microgravity environment enhances the study the capillary dominated phenomena affecting the dynamic and static behavior of liquid drops in air and gas/vapor bubbles in liquid. Applications include the collection and removal of moisture in microgravity for humidity control.

HST research in this area includes surface-tension-related phenomena that may dominate fluid behavior. For example, the handling and storage of fluids may require the use of vanes, wicks, and screens that rely on capillarity to control the location of the fluid. Heat pipes and capillary pumped loops also depend on surface tension effects. Condensation, evaporation, and boiling, are influenced by both gravity and interfacial forces.

Ground-Based Facilities

Investigators often need to conduct reduced gravity experiments in ground-based facilities during the experiment definition and technology development phases. The NASA ground-based reduced gravity research facilities include the KC-135 research aircraft at the Johnson Space Center, which provides approximately 20 seconds of low gravity testing, and two drop towers at

the Glenn Research Center: the 2.2-Second Drop Tower and 5.18-Second Zero-Gravity Facility. A variety of specialized test rigs are also available to conduct a wide range of microgravity fluid physics research: Two Phase Flow Test Rig, Computational Microgravity Lab, and Motion Analysis and Object Tracking System.

Fluid Physics Diagnostic and Measurement Capability

NASA has adapted or developed a number of diagnostic and measurement techniques for microgravity fluid physics research that are available for research on Earth. Examples include Laser Tweezers, Surface Light Scattering Hardware, Interferometry, Velocimetry, Birefringence, Diffusing Wave Spectroscopy (DWS), Rainbow Schlieren Reflectometry, Flow Pattern Visualization, and Liquid Surface Temperature and Vapor Phase Concentration Measurements.

NASA Technical Contacts

Questions about fluid physics research may be directed to the Microgravity Fluid Physics Enterprise Scientist:

Dr. Francis Chiaramonte
Code UG/Physical Sciences Division
NASA Headquarters
300 E Street SW
Washington, DC 20546-0001
Telephone: 202-358-0693
E-mail: fchiaram@hq.nasa.gov

Technical and programmatic materials are available upon request from:

Dr. Bhim Singh
NASA Glenn Research Center
21000 Brookpark Road, MS 77-5
Cleveland, OH 44135
Telephone: 216-433-5396
Bhim.S.Singh@nasa.gov

B. Michael Lawson
Mail Code EC
NASA Johnson Space Center
2101 NASA Road One
Houston, TX 77058
Telephone: 281-483-9124
b.m.lawson@nasa.gov

For additional information, investigators should refer to the following web sites:

Fluid Physics: <http://microgravity.grc.nasa.gov/6712/research.htm>

Advanced Life Support: <http://advlifesupport.jsc.nasa.gov/>

Supporting Documents

Further information about the Fluid Physics Research Area can be found in the following documents or conferences proceedings:

Strategic Research to Enable NASA's Exploration Missions Conference. Hosted by NASA Glenn Research Center and the National Center for Microgravity Research on Fluids and Combustion, June 22-23, 2004, <http://www.ncmr.org/events/fluids2004>

Bioastronautics Critical Path Roadmap. http://research.hq.nasa.gov/code_u/bcpr/index.cfm

Chiaromonte, F. and Joshi, J., “Workshop on Critical Issues in Microgravity Fluids, Transport, and Reactor Processes in Advanced Human Support Technology,” NASA/TM 2004 – 212940, February 2004.

McQuillen, J., et al, “Strategic Research – Workshop on Two-Phase Flow, Fluid Stability and Dynamics: Issues in Power, Propulsion and Advanced Life Support Systems,” NASA/TM 2003 – 2/2598, May 15, 2003. <http://www.ncmr.org/events/multiphase/>

Report to NASA from the Fine Particulate Workshop, May 2003, <http://www.ncmr.org/events/particulate>

Sixth Microgravity Fluid Physics Conference Proceedings, National Center for Microgravity Research on Fluids and Combustion, Aug. 2002, <http://www.ncmr.org/events/fluids2002/>

Motil, B., “Workshop on Research Needs in Fluids Management for the Human Exploration of Space,” <http://www.ncmr.org/events/fluidsmgmt/multiphase.html>, NASA-GRC, Sept. 22, 2000.

Viskanta, R. et al, “Microgravity Research in Support of Technologies for the Human Exploration and Development of Space and Planetary Bodies,” Topical Report of the National Research Council – Space Studies Board, 2000.

Eckart, Peter, The Lunar Base Handbook, Space Technologies Series, McGraw-Hill Companies, Inc. 1999.

The Office of Biological and Physical Research Tasks and Bibliography. <http://research.hq.nasa.gov/taskbook.cfm>

IV. HARDWARE AND FACILITY DESCRIPTIONS

For a listing of NASA hardware and facilities available in support of the Biological Research solicited in this Announcement, please refer to the **Space Life Sciences Ground Facilities Information Package**, which is available at:

http://research.hq.nasa.gov/code_u/nra/current/NNH04ZUU004N/index.html.

A list of hardware, facilities, and diagnostic capabilities available or planned for use in the microgravity Fluid Physics program is listed below. Detailed descriptions of those hardware and facilities are provided on the following Web sites:

http://spaceresearch.nasa.gov/research_projects/nrahardware.html

and

http://spaceresearch.nasa.gov/research_projects/facilities.html.

**RESEARCH OPPORTUNITIES IN SPACE BIOLOGICAL AND PHYSICAL
SCIENCES, HUMAN SUPPORT TECHNOLOGY**

APPENDIX B: SAMPLE FORMS

CHECKLIST FOR PROPOSERS

(U.S. Proposals Only-attach one copy to the submittal letter)

- ☐ Checklist for Proposers (Form A)
- ☐ Proposal Cover Page (completed online)
- ☐ Response to previous reviews (if applicable)
- ☐ Project Description
- ☐ Biographical Sketches (Form B)
- ☐ Facilities and Equipment Description
- ☐ Summary Budget /Budget Justification (Form C)
- ☐ Detailed 12-Month Budget (for each year of support) (Form D)
- ☐ Other Support (Form E)
- ☐ IRB or ACUC letter/form (if applicable)
- ☐ Letters of Collaboration/Support (if applicable)
- ☐ Appendices, if any

Form B

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel.
Photocopy this page or follow this format for each person.

NAME	POSITION TITLE		
EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training).			
INSTITUTION(S) AND LOCATION	DEGREE(S) (if applicable)	YEAR(S)	FIELD(S) OF STUDY

RESEARCH AND PROFESSIONAL EXPERIENCE: Concluding with present position, list, in chronological order, previous employment, experience, and honors. Include present membership on any Federal Government public advisory committee. List, in chronological order, the titles, all authors, and complete references to all publications during the past three years, and to representative earlier publications pertinent to this application. If the list of publications in the last three years exceeds two pages, select the most pertinent publications. **DO NOT EXCEED TWO PAGES.**

Form C

BUDGET FOR ENTIRE PROJECT PERIOD

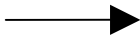
DIRECT COSTS ONLY

<i>BUDGET CATEGORY TOTALS</i>		<i>1st BUDGET PERIOD</i>	<i>ADDITIONAL YEARS OF SUPPORT REQUESTED</i>		
			<i>2nd</i>	<i>3rd</i>	
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT					
SUPPLIES					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES					
TOTAL DIRECT COSTS FOR EACH PERIOD					
TOTAL INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD					
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT					

JUSTIFICATION FOR UNUSUAL EXPENSES :

BUDGET FOR 12 MONTH PERIOD

DIRECT COSTS ONLY

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD DIRECT COSTS ONLY		FROM		THROUGH	
Duplicate this form for each year of grant support requested		FUNDING AMOUNT REQUESTED			
PERSONNEL (Applicant Organization Only)					
NAME	ROLE IN PROJECT	EFFORT ON PROJECT	SALARY	FRINGE BENEFITS	TOTALS
	Principal Investigator				
SUBTOTALS 					
SUBCONTRACTS					
CONSULTANT COSTS					
EQUIPMENT (Itemize; use additional sheet if needed)					
SUPPLIES (Itemize by category; use additional sheet if needed)					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES (Itemize by category; use additional sheet if needed)					
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD					
TOTAL COST FOR FIRST 12-MONTH BUDGET PERIOD					

Form E**OTHER SUPPORT**

Please provide information regarding specific sources of other support for the PI and each Co-I (not consultants). This information should be provided separately for each individual in the format shown below. List all active support for an individual before listing pending support. Include the investigator's name at the top of each page and number pages consecutively.

NAME OF INDIVIDUAL		
ACTIVE/PENDING		
Project Number (Principal Investigator)	Dates of Approved/ Proposed Project	Percent Effort
Source	Annual Direct Costs	
Title of Project (or Subproject)		
One-sentence description of project goals. (The major goals of this project are...)		
Brief description of potential scientific or commitment overlap with respect to this individual between this application and projects described above (summarized for each individual).		